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Rip Current Education

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## Public Understanding and Knowledge of Rip Currents and Beach Safety in the UK

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Rip currents present a severe hazard for water users on beaches and account for the greatest cause of lifeguard rescues worldwide. The physical dynamics of rip currents are well studied, and more recently, the social and behavioral science research surrounding human interaction of rip currents has been expanding, providing a social perspective and feeding into public education strategies. The aim of this study was to assess levels of public understanding of rip currents and beach safety on UK beaches. A questionnaire was undertaken ( $N = 407$ ) during the summer of 2012 on four beaches. Beach users had a poor knowledge of rip currents ( $n = 263$ ), but those who have been caught in a rip before have a higher level of knowledge. Conversely, beach users had a good understanding of what the beach safety flags indicated ( $n = 314$ ), and most people complied with this flag system ( $n = 339$ ). In addition, those previously educated on rip currents had a higher knowledge, and lifeguards proved to be the most effective form of education. The study presents an insight into UK beach users' knowledge of rip currents and provides more evidence with which to pilot a rip current education scheme within the UK.

*Keywords:* drowning, rip currents, beach lifeguards, beach safety education

The purpose of this study was to determine levels of knowledge and understanding of rip currents and beach safety by typical summer beach users in the United Kingdom (UK). In addition, the study sought to establish where individuals obtained their knowledge about rip currents for two reasons: 1) to gauge the effectiveness of how and where this knowledge was obtained, and 2) how education strategies need to be developed or improved. In their study of a rip current intervention program, Hatfield, Williamson, Sherker, Brander, and Hayen (2012) concluded that education and campaigns do improve rip current awareness. Therefore to develop such a scheme in the UK, we needed to know current levels of understanding on UK beaches by measuring existing awareness, knowledge, and attitudes before attempting to influence or alter them. The broader aim of the work was to provide the basis for a new rip current education scheme for the UK using this baseline knowledge level.

Beaches present an attractive, enjoyable environment for recreation and tourism, drawing millions of visitors to the coastal regions of the UK and the rest of the world. Beaches exhibit a variety of hazards with visitors, often unknowingly, placing themselves within an inherently risky environment (Short & Hogan, 1994; Ballantyne, Carr, & Hughes, 2005; Scott, Russell, Masselink, & Wooler, 2009). These hazards are mitigated by the introduction of lifeguard services on beaches, for which the Royal National Lifeboat Institution (RNLI) is the operating organization within the UK. Lifeguard services operate on 214 beaches within the

UK between May and September, with 29 beaches beginning the service at Easter and 14 of those beaches extending through to November.

At lifeguarded beaches in the UK, safe bathing areas are denoted by red and yellow flags, in accordance with the International Life Saving Federation (ILSF) recommendations, with lifeguard patrols present at the water's edge. Due to the large tidal ranges in the UK, bathing areas may vary in position during the course of the tide and as hazards become exposed or disappear depending on conditions. International research on beach safety flags has shown that people are safest to go in the ocean between the patrol flags and that most fatalities occur outside these areas (Sherker, Williamson, Hatfield, Brander, & Hayen, 2010). In addition, studies have found that people know the flags indicate safe bathing areas and know they should swim between them, yet a proportion of people still choose to swim outside the flags (Ballantyne et al. 2005; White & Hyde, 2010; Wilks, DeNardi, & Wodarski, 2007; Sherker et al. 2010).

The reasons behind why people choose to swim away from patrolled areas are complex and can be associated with intentions and decision making within the realms of the Theory of Planned Behavior (White & Hyde 2010). Swimming outside the flags also exposes water users to the risk of getting caught in rip currents. It has been reported that 73% of rip current survivors were outside of patrolled areas at the time of an incident (Drozdowski et al. 2012). Rip currents are strong rapid seaward flowing channels of water capable of moving people from shallow to deeper water quickly and unexpectedly, thus presenting a significant hazard to shore water users (Brander, 1999; MacMahan et al. 2010). Lifeguard best practice dictates flags are placed on sandbanks as rip currents flow out to sea in channels flanking sandbanks, so it is not surprising that people are caught outside of these extents which mark the safest areas of the beach.

The morphodynamics of a beach dictates what type of hazard is prevalent within the surf zone and is a well-researched topic (Short & Hogan 1994; Benedet, Finkl, & Klein, 2004; Scott, Russell, Masselink, Wooler, & Short, 2007; Scott et al. 2009). Beaches that develop sand bars and troughs are prime for rip current development (Wright & Short, 1984). Scott et al. (2009) investigated rip rescues as a function of beach morphodynamics and hydrodynamic forcing and found that 59% of the UK's west coast beaches have 'Low Tide Bar/Rip' and 'Low Tide Terrace and Rip' morphodynamics that can produce multiple rip systems in this high-energy setting (Figure 1). On these beaches, small summer swell waves favor the intermediate beach morphodynamic systems associated with strong rip currents (Scott et al. 2007; 2008; 2009) at a time when large summer visitor numbers expose more people to the rip current hazard, resulting in higher numbers of rescues (Scott et al. 2007; Woodward, Beaumont, Russell, Wooler, & Macleod, 2013). The UK also has a large tidal range (mean 5.5 m) which has a major impact on the severity of rip currents, particularly as large spring low tides occur in the middle of the day, activating the low tide bar/rip morphology at the same time as maximum beach and bather populations appear (Scott et al. 2009).

**\insert figure 1 here\**

The number of people drowning and being rescued from rip currents globally has received a lot of attention. In Australia, an average of 21 people per year drown in rip currents (Brighton, Sherker, Brander, Thompson, & Bradstreet, 2013); in the U.S., Gensini and Ashley (2010) reported that on average 35 people per year drown in rip currents. Kumar and Prasad (2014) recently presented data from India, where rip currents claim approximately 39 lives every year. Rip currents are largely quoted as the greatest cause of lifeguard rescues across the globe (Brander & MacMahan, 2011; Brewster & Gould, 2014; Brighton et al. 2013; Klein, Santana, Diehl, & Menezes, 2003). In the UK, rip currents represent 68% of all

lifeguard rescues (Scott et al. 2008). Woodward et al. (2013) further scrutinized the UK pattern by investigating the demographics of rip current casualties and concluded that male teenagers were most likely to be caught in rip currents, and that people bodyboarding on beaches along the north coast of Devon and Cornwall in the southwest UK were at most risk.

The physical dynamics of rip currents has been well studied. Shepard, Emery, and La Fond, (1941) defined the traditional understanding of rip currents while more recent studies have introduced GPS surf zone drifters to accurately measure the direction and circulation patterns of rip currents (Austin et al. 2010; MacMahan, 2005, 2010; McCarroll et al. 2014), greatly improving understanding of rip currents worldwide. This method also effectively relates the physical dynamics of rips to the human element, as the drifters mimic people in the water. This progression in rip current knowledge has further implications for beach safety, particularly with respect to rip circulation, as the flow of rip currents has an effect on what safety messages to disseminate to the public, especially swimmer escape strategies (McCarroll et al. 2014; Miloshis & Stephenson, 2011).

In more recent years, there has been emphasis on the social and behavioral sciences as they relate to rip currents. A need for rip current intervention programs and research on beach users attitudes, behaviors, and understanding of beach safety and rip currents has been highlighted (Brander and MacMahan 2011; Sherker et al. 2010). Researchers in this field agree that beach users need to know how to identify a rip current to avoid swimming in one (Sherker et al. 2010) and that rip identification needs to be a crucial part of rip education (Williamson et al. 2012). Social rip current research is developing and improving as studies such as those investigating the knowledge of how people behave in rip currents (Drozdowski et al. 2012). For example, in the U.S. it has been highlighted that there is a poor general public understanding of rip currents (Brannstrom, Trimble, Santos, Brown, and Houser, 2014; Caldwell, Houser, and Meyer-Arendt, 2013). This survey study aims to provide a UK perspective on how much beach users know and understand about rip currents, adding to international research and effort on rip current awareness, education and prevention of drowning.

## **Method**

### **Study Sites**

Beach locations were selected on the findings from Woodward et al. (2013) where beaches with higher rip current incidents were identified. A mixture of rural and resort beaches were chosen on the north coast of Devon and Cornwall in southwest UK (Figure 2) due to ease of access and exposure to large numbers of people. These beaches were Croyde (A) in Devon, and Constantine Bay (B), Perranporth (C), and Chapel Porth (D) in Cornwall. These four beaches account for approximately one quarter of all UK rip incidents over a six-year period (2006–2011). The beaches are macrotidal and are exposed to Atlantic swell and wind waves from the prevailing westerly winds. Each site was visited twice over a two-week period with the exception of Croyde which was visited once. The physical characteristics of each site are outlined in Table 1.

**\insert figure 2 here\**

**\insert table 1 here\**

### **Survey Design**

The public beach user questionnaire was semistructured with a mix of 26 closed and open ended questions to generate quantitative and qualitative data (Appendix A). It comprised six

sections: general beach background, beach safety knowledge, rip current knowledge, rip current experience, rip current education, and demographic information. This was designed as a face-to-face survey to maximize the quality of data collected and to obtain the highest response rates. Ethical approval was granted by the Human Ethics Committee of the Faculty of Science and Technology at Plymouth University, UK.

## Procedure

The research team were present on the beach from 11:00 a.m.–5:00 p.m. (Table 2). A random sampling method was selected where a team of 2–4 interviewers approached beach users situated within a chosen transect anywhere between beach access points and the water's edge. Interviewers spent an average of 10 min with each participant, on occasion longer if there were questions or explanations needed after the survey. The questionnaires for this study were conducted during summer 2012 during July 30–August 9 to coincide with peak summer beach populations, ensuring higher survey responses.

\insert table 2 here\

## Results

### Respondent Profile

A total of 407 beach surveys were conducted with a 96% response rate owing to large receptive audiences (Table 2) and a margin of error of 4.76% at a 95% confidence interval. The mean age of respondents was 39 (median = 42, range = 9–75) and a near even split between males ( $n = 198$ ) and females ( $n = 209$ ). Eighty-three percent of respondents were on holiday, and those with postcodes corresponding to the beaches surveyed (TR, PL, EX) were deemed to be local and made up only 14% of respondents. The remaining respondents were from the rest of the UK (83%) with a small proportion from overseas (2%). Participants had undertaken an array of water-based activities throughout the year with swimming (29%), bodyboarding (28%), and paddling (19%) the most frequent. Conversely, during winter months (December–February) 74% did not go in the sea, although 10% surfed and 6% bodyboarded. Participants gave 1,314 responses to what influenced their choice of beach when asked to give three main reasons. It was noted that waves (26%), sand (26%), and cleanliness (19%) were the key influences for respondents' beach selection. These initial 1,314 responses were later coded into 19 themes where sea conditions (13%), physical features (12%), and safety (8%) then became the main influence categories.

### Rip Current and Beach Safety Knowledge

Open-ended questions were used to gain what participants understood about rip currents. These qualitative responses provided richly detailed information and were analyzed and ranked on a scale of 1–5 (See Table 3). Beach users' level of rip current knowledge was generally poor (Figure 3a), with 32% giving entirely incorrect answers and another 33% gave poor responses which combined for almost 2/3 (65%) of respondents who had wrong or poor knowledge about rip currents. Those who gave a good or excellent answer totalled only 10%. Male respondents had a higher knowledge level than females, where poor answers for males and females were 58% and 70%, respectively, and good answers 14% and 6%, respectively. Age group differences were not as pronounced as gender, but analysis found those aged 0–12 had the highest number of poor answers (64%), followed by those aged 36–45 (51%) and those 65 and older had the lowest number of poor answers with 36%. There were no large differences between study sites and knowledge, with each beach following the main trend.

\insert table 3 here\

\insert table 4 here\

Rip current knowledge levels were compared with knowledge of the beach flag system. The majority of beach users had a good understanding of what the red and yellow safety flags meant on the beach. Responses were again assigned a position from 1–5 on a knowledge scale (Table 4), and those who were incorrect or gave a poor answer combined to represent 4% of respondents (Figure 3b). Those with a good or excellent knowledge level accounted for 77% of respondents who mentioned all or a combination of safety, type of activity, and that the flags marked an area in which to stay between.

\insert figure 3 here\

Sixty-four percent of respondents said they always went to a lifeguarded beach, and 97% of respondents were able to give a reason why the lifeguards placed the red and yellow flags where they do on the beach, with 61% outlining that they get placed in the safest areas of the beach and to avoid strong currents. Acting on this knowledge was similar with 86% of those who went in the water while being compliant with the safety system stating they always go between the designated flagged zones for their chosen activity. The main reasons for this amenable action were predominantly safety and that there is a constant lifeguard patrol. Those who sometimes entered the water between the flags (11%) stated they went outside mainly due to the type of activity they undertook, where on occasion sea conditions were better in areas of the beach away from the flags, such as those who were going surfing. Others ventured into the water away from the flags because they sometimes believed the zones to be too busy with people and equipment. Individuals who typically do not go between the flags stated they would go to the patrolled areas when they were with their children or family members to set a good example.

The activities and frequency of water use were analyzed to investigate whether rip current knowledge is affected by time in the water and type of activity. Respondents were asked to state which activities they undertook throughout the year, broken down into the four seasons. The majority of people only went in the water in the summer months (59%), and those who participate in water-based activities on a year round basis mostly surfed. Figure 4 shows that rip current knowledge increases with a greater frequency of water use. The type of activity however, does not appear to have a bearing on rip current knowledge.

\insert figure 4 here\

### **Rip Current Experience**

When asked if the respondent had ever been caught in a rip current, 25% stated that they had, with more males answering yes than females (35% vs. 14%). The main activities at the time of incident were bodyboarding (35%), swimming (32%), and surfing (21%). The highest number of these incidents occurred on Perranporth, Chapel Porth, and Constantine Bay beaches in the UK. A significant proportion of respondents who had been caught in a rip stated they had been caught in them while at a beach in Australia. Escape strategies were chosen from a prescribed list, where 56% of people self-rescued, of which 26% swam parallel to the shore, and 80% did not signal to anyone for help. Reasons why people did not signal for help were varied: 35% felt confident and at ease with the situation, 5% were using the rip deliberately for their activity, and 12% were caught in a rip out of lifeguard hours or on a nonpatrolled beach. Lifeguards saw and were on their way to 10% of people whereas 7% were too busy swimming to be able to signal, and 3% were too proud to signal.

Figure 4 shows that rip current knowledge increases with water use. Subsequent analysis therefore was undertaken to establish whether there is a correlation between being caught in a rip current and frequency of water use. Figure 5 shows that the probability of being caught in a rip current does increase with water use. Summer only water users who have been caught in a rip total 14% compared with 60% of year round water users. The activity most participated in throughout the year is surfing, consistently averaging 22% per season, whereas bodyboarding and swimming peak in summer months but decrease for the other three seasons.

**\insert figure 5 here\**

As frequency of water use increases, it appeared that water experience and possibly knowledge and identification of rips also increases. It should also be noted that with more water experience and rip current knowledge could come increased usefulness of a rip (e.g., for a surfer to get out beyond the break easily). Levels of rip current knowledge, therefore, were analyzed between the groups of 'caught' and 'not caught' to find that those who have been caught in a rip do indeed have a higher level of rip current knowledge (Figure 6). Those with the highest knowledge (good and excellent, 19%) predominantly frequented the water all year round (73%) and surfed (37%). There is still a high level of incorrect and poor knowledge of rip currents (49%) among those who have been caught in a rip, but there is a definite shift from poor to good knowledge (Figure 6). Incidentally, there was no difference in beach flag knowledge between those who had been caught or not caught in rips with averages of 3.8 and 3.7 on the knowledge scale respectively.

**\insert figure 6 here\**

It should also be mentioned that 11 respondents were unsure whether they had been caught in a rip or not. Knowledge levels were analyzed with 82% giving an incorrect description of a rip current. This potentially indicated their uncertainty of the incident was due to poor identification. Water use analysis indicated 45% were summer water users and 9% didn't go into the sea. Whether their rip current experience put them off going in the sea or not was unknown.

## **Rip Current Education**

Results from the questionnaire also established whether beach users had received or acquired any type of rip current education, and if so, where that education came from. Respondents were asked to state what form of rip current education they may have had, whether directly through being taught specific information during a course or from a lifeguard, or indirectly via signage, media, or entirely subliminally. Just over three quarters (76%) of respondents had never received any form of rip current education. Gender differences highlighted that 27% of male respondents had received education compared with 21% of females, and the age group with the highest proportion of education were 19–25 year olds (37%). It should also be noted that one third (33%) of 13–18 year olds, who were outlined from UK rip current rescue statistics to be most at risk (Woodward et al. 2013), had acquired rip current education, and those aged 65+ total the lowest proportion (6%). Respondents with a local postcode to the beaches visited (TR, PL, EX) had received the highest proportion of education (27%). Of the 24% of respondents who have had some form of rip education, courses such as water sport lessons and surf lifesaving clubs returned the highest proportion of responses (31%), followed by educational establishments (16%) and lifeguards (14%). The lowest, with less than 3% of all responses, included the factors of signage, Internet research, and television.

Analysis was done to establish which form of education yielded the highest and lowest rip current knowledge levels. Respondents without education returned 70% incorrect and poor on

the knowledge scale combined, compared with 48% of those who had obtained education. Good and excellent knowledge accounted for 6% of those without education, and 21% of those with education. These results show that those who had received some form of education about rip currents had higher knowledge levels of the subject. The form of education which yields highest knowledge levels was lifeguards with 36% of that group registering within the 'good' scale category, and inversely leaflets yield the lowest with 50% falling within the 'incorrect' scale bracket.

Respondents also were asked to provide ideas for the best methods on how to educate the public about rip currents, what form of education that may be, how and where it could be delivered, as well as the form of education they personally would be most receptive to. Signage was suggested the most with 24% of responses, 5% of which were specific dynamic signs displaying rip current information as conditions changed throughout the day, mobile signs at the water's edge, and beach specific signage that are highly noticeable. Communication from lifeguards was the second highest response (10%). When asked in the field, a vast proportion of people were very uncertain, often vaguely supposing some form of education would work. There were also, however, a small proportion of people who were firmly confident in their method suggestion. Half of all respondents thought any form of education should be delivered on the beach, in the environment where the hazard is present.

Respondents were asked to select from a prescribed list, what methods of education they would be most receptive to if there were to be a new rip current education scheme (Table 5). Having a conversation face to face with a lifeguard was chosen the most (18%) followed by television and signage. Table 5 shows all respondents, and also gives a breakdown of answers from those caught and not caught in a rip current. The main differences between these two groups were that those who have been caught rank lifeguards above demonstrations and signage, and those who haven't been caught rank television above signage and lifeguards. Information via the radio or a smartphone application were the least popular methods.

\insert table 5 here\

## Discussion

### Beach Safety Knowledge

This study found that 77% of UK beach users surveyed had a good level of knowledge of the red and yellow bathing area flags. This proportion of respondents were able to state what activity should be undertaken, that the flags indicated a zone within which to stay, and that it was safe and patrolled by lifeguards. These flags denote the safest areas of the water between which to swim or use bodyboards, and also highlight there is a lifeguard patrol present on the beach. Beaches with a high hazard rating will support a lifeguard patrol, and generally coincide with popular tourist destinations, therefore the high percentage of good, and even satisfactory understanding of the flags is expected due to the high presence of lifeguard patrols on UK beaches. Those with a poor knowledge totaled 1% and were only deemed poor due to stating an incorrect activity. Those with an incorrect response totaled 3% and could not give, or even attempt, an answer to the question. These figures are consistent with the findings of Caldwell et al. (2013) in the U.S., but are not as impressive as Australian beach users where a study found all but one respondent was correct (Ballantyne et al. 2005), perhaps showing a cultural difference, where beaches and surf lifesaving are such a major part of Australian coastal life.

With a good understanding of the safety flags, 86% of respondents stated that they always go between the flags when entering the water on a lifeguarded beach. Safety is the main

reason cited, in addition to their knowledge that the area is patrolled by the lifeguards, and that some think it is best for their children and family. Going to a lifeguarded beach is a conscious decision for 64% of respondents, although coincidence and chance play a part to some, and once there RNLI lifeguards anecdotally report that British beach users are generally compliant with the safety flags and adhere to lifeguard advice (Figure 1). Whether this is due to a herd mentality, because people don't know any different, or because they do as they are told is unclear. This is in part due to a lack of depth when asking about lifeguard flag placement, as respondents provided an answer which was not wrong, but it is uncertain whether they knew *why* or if it was just a guess. What is known is that red and yellow flag knowledge among this group of beach users is good, and that there is a general respect for the lifeguards who are extremely preventative in their approach to keeping beach users safe.

In comparison, actions of individual beach users with a negative behavior and attitude toward safety flags in this survey (i.e., do not go between the flags) vary with experience, activity, the occupation of the flagged area, and levels of application in freedom of choice. Although this study does not provide enough evidence to investigate the psychological reasons behind beach users' water-based locations and their attitudes behind why they choose specific areas, the data does provide these short responses for going between the flags. Even with an understanding the flag system, this minority don't always act on their knowledge and still undertake risky behaviors such as going outside of lifeguarded areas, as supported by similar studies (Ballantyne et al. 2005; McCool, Moran, Ameratunga, and Robinson, 2008; Sherker et al. 2010). Whether this is a conscious decision or peer pressure, or whether experience overrules subjective risk, or that sense of control over their actions comes to the fore is uncertain. These psychological implications are further found in studies by White and Hyde (2010) and Williamson et al. (2012) in relation to swimming location and rip current hazard. The importance of understanding motivational factors, intentions, and risk perception of beach users is therefore paramount in managing beaches effectively and developing education materials, and is too detailed for this survey but deserves a study in its own right.

### **Rip Current Knowledge**

Safety is a concern for people visiting the beach in the UK, where the main influences of respondents' beach choice were the sea conditions, physical features, and safety respectively. Rip currents account for the highest number of lifeguard rescues in the UK, and worldwide, yet beach users are typically unknowledgeable or even unaware about them. This study found that 65% of beach users have a poor knowledge of rip currents despite having a good knowledge of the safety flags (Figure 3). Those within the 'incorrect' category generally stated that a rip current is invisible, an undercurrent, or something that will drag you under, whereas those with a 'poor' answer included an incorrect description counterbalanced with a correct statement such as offshore flow direction. A quarter of beach users gave a satisfactory response which included a statement that was correct but did not explain enough detail of the mechanics behind a rip current to be a good answer. Consistent with the findings of those in Australia (Sherker et al. 2010; Williamson et al. 2012) and in the U.S. (Brannstrom et al. 2014; Caldwell et al. 2013), this study adds to worldwide research that identifies a typical beach user to have a poor knowledge of rip currents.

### **Rip Current Experience**

In this study, 25% of respondents had been caught in a rip current, with an overrepresentation of males compared with females (35%:14%). Respondents' descriptions of the incidents are consistent with results from UK beach lifeguard incident statistics which outlined male teenagers, the north coast of Cornwall, and bodyboarding to be the key demographics,

location, and activity of people caught in rip currents (Woodward et al. 2013). Literature in this field has long established a male dominance in drowning and incident statistics, and essentially links males with overconfidence in their abilities and an underestimation of risks, but also the simple fact that males are exposed to rip currents more than females by spending more time in the water and venturing further out to sea (Gulliver and Begg 2005; McCool et al. 2008; Moran 2008; Morgan, Ozanne-Smith, and Triggs, 2009).

Rip current knowledge levels of this group were analyzed and found that they were able to describe a rip current in more detail and had a higher level of knowledge than those not caught in a rip (Figure 5). This demonstrates that the experience of being caught in a rip current provides a greater level of awareness and understanding of the hazard, a finding similar to that of Drozdowski et al. (2012). It is uncertain however, whether rip victims have advanced levels of knowledge because of being caught in a rip, or if they are caught in a rip because of their advanced knowledge due to a developed water competence, confidence and rip identification skills. What can be inferred, and echoed by Sherker et al. (2010), is that those with rip experience are better placed to make decisions about where to enter the water, and are more confident in their reaction if caught in one.

This study has shown that more frequent water use increases the probability of being caught in a rip current (Figure 4). It is also known that rip current knowledge improves with increased water use (Figure 3). It is no surprise that increasing exposure to the hazard raises the risk of being caught, but perhaps activity, location, and time of year can somewhat account for this. It is also no surprise that increased participation of an activity will lead to a better understanding of the environment in which it is conducted. In this study, surfing accounts for the most consistently undertaken activity year round, with a quarter of all respondents surfing during winter months. In the UK, waves for surfing are often more consistent and powerful outside the summer months due to more frequent mid-Atlantic depressions, and with a dedicated cold water surfing community, exposes surfers to rip currents year round. In addition to this, lifeguard patrols cover beaches between the hours of 10:00 a.m.–6:00 p.m. from April through to October, enhancing the risk to water users entering the water outside of these hours. It is therefore even more important to educate on rip currents to this group of water users, especially novices and improvers, who will continually be exposed to the rip current hazard particularly year round when lifeguard patrols may be absent, and sea conditions more dangerous.

## **Rip Current Education**

One quarter of beach users in this study have received some form of rip current education, and subsequently have a higher knowledge of rips compared with those who have not been educated on rips. These results provide an argument in favor of beach safety education and more specific rip current material, to provide beach users with information on hazards within their leisure environment, enabling them to make safe decisions, and present them with options if a danger presents itself. This is reinforced by findings from Klein et al. (2003) where a successful beach safety campaign led to an 80% reduction in fatal accidents, and Hatfield et al. (2012) where a campaign effectively improved beach users' knowledge of, and behaviors around rip currents. This study, supported by the aforementioned examples of successful beach safety campaigns, provides further evidence for continuing the process of creating and implementing a rip current education pilot in the UK.

Rip current education has come in many forms to the respondents in this survey, and the largest proportion has come from courses and clubs on the beach, educational establishments and lifeguards. Lifeguards, however, proved to be the most effective form of education as

36% of those educated by lifeguards had a 'good' knowledge of rip currents. This provides support for the RNLI to continue to use their lifeguards to inform the public about rip currents on hazardous beaches. It is also noted that educating people in the environment where the hazard is present is successful, but whether specific audiences (such as teenage males) can be effectively reached in this situation remains ambiguous from this study. It has been shown, however, that an increase in lifeguard preventative actions, resources, and importance has positive results on incident and drowning statistics (Klein et al. 2003), so a concentrated effort to reach certain demographics with cleverly designed marketing or incentives utilizing lifeguards could be the key to rip current education.

As an alternative to lifeguards, signage was stated by 29% of respondents as the most effective way to educate about rip currents. Though a popular solution, signage only accounted for 0.5% of those who have received rip current education, and as 65% of these respondents had a poor knowledge of rip currents, they may have found it difficult know the best methods to educate on the subject. A study on beach safety signage undertaken by Matthews, Andronaco, and Adams (2014) suggested that this method was not as effective as authorities believed, suggesting that public awareness campaigns may be the best and only way to communicate hazards on beaches. Signage, however, when researched and implemented correctly, can have a positive impact on transmitting hazards. Rousseau and Wolgater (2006) suggest the presence of warning signs have a significant effect on compliance behavior, and that attempting to communicate something is better than nothing, but more importantly, successful signs will display information on what people already know rather than expecting people to learn something new. In this respect, it could be argued that as the results of this study show people know more about beach flags than rip currents, information about the flags and *why* they are placed there (i.e., to avoid rip currents) should be conveyed via signage. Whether signage works effectively is uncertain, but studies undertaken on beach signage proves it is unsuccessful, and is clear more research needs to be done on this topic to ensure the most effective rip current signage is used.

## Conclusions

A questionnaire was delivered to 407 beach users during the summer on UK beaches to determine the current levels of awareness of beach safety and rip currents. This study not only provided an insight into the UK beach user, but further contributes to the field of social rip current research, and presents a benchmark from which to progress the education of rip currents to the public. Education in whatever form must develop from evidence and provide the public with the best tools, communicated in the most effective way, to keep them safe at the beach. The effects of educating the public on beach safety, in particular rip currents, are positive, and can lead to reductions in incidents. Based on this study the following conclusions can be drawn:

- The level of rip current knowledge among UK beach users is poor ( $n = 263$ , 65%), with only 35% ( $n = 144$ ) giving a correct description of a rip current. This poor level of rip current knowledge indicates the need to increase education on the topic.
- Conversely this group had a higher knowledge of the beach safety flags with 96% ( $n = 389$ ) able to give a correct description of what the red and yellow flags indicate. Good knowledge of this topic accounted for 77% ( $n = 314$ ) of respondents.
- With a good understanding of the beach safety flags beach users complied with the flag system ( $n = 339$ , 86%) and three quarters ( $n = 309$ , 75%) had not been caught in a rip current. This demonstrated that entering the water between the flags reduced the risk of being caught in a rip current. This emphasizes the value of general beach

safety and the importance of attending a lifeguard-patrolled beach during operational months and hours.

- Those who had been caught in a rip current have a greater knowledge ( $n = 50$ , 51%) of rip currents than those who have not been caught ( $n = 93$ , 31%). This provided further evidence that experience of being caught in a rip current was the best way to demonstrate the hazard, presenting victims with the physical and mental awareness of what a rip current does and how it can affect water users.
- Lifeguards have proven to be the most effective form of rip current education and a popular source for disseminating future education. Lifeguards should therefore be included in any rip current education schemes that may be developed.

With results from this study, the UK rip current incident statistics, and a further study of people caught in rip currents, efforts can be put forward into developing a rip current education pilot for the UK.

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**Figure 1** —

**Figure 2** —

**Figure 3** —

**Figure 4** —

**Figure 5** —

**Figure 6** —

**Table 1**

<b>Beach and morphology</b>	<b>Description</b>	<b>Rip incidents (2006–2011)</b>
Perranporth LTB/R	Large exposed west facing sandy beach bounded by headlands at each end of a 3.5 km beach backed by dune system (0.5km at high tide) Resort town with several large car parks serving the high volume of seasonal visitors. RNLI lifeguards.	Total = 414 UK % = 7.14
Chapel Porth LTB/R	Small rocky cove at high tide becoming large sandy beach at low tide (1.25 km). Joins with Porthtowan to the south at spring low tide and bounded by headlands (2.5 km). National Trust beach and car park with limited numbers, other car park 10 min walk up hill. Small café and public conveniences. RNLI lifeguards.	Total = 153 UK % = 2.64
Constantine Bay LTT+B/R	Large sandy beach backed by dune system with rocky outcrops to the south and headland to the north. Joins with Booby's Bay at low tide (1 km). Small car park in quiet village popular with seasonal visitors. RNLI lifeguards.	Total = 253 UK % = 4.36
Croyde LTB/R	Large sandy beach backed by dune system bounded by headlands (0.8 km). Resort village popular with seasonal visitors, accommodation close to the beach and several car parks and beach entrances. RNLI lifeguards.	Total = 640 UK % = 11.04

**Table 2**

Est. Beach Populations									
Beach	Min.	Max.	Mean	Samp. R (%)	Resp. [AUG]	Ref.	Resp. R (%)	Pers.	Wx
Perranporth.	150	5500	4000	2	72	3	95.83	4	Sun-cloud
Chapel Porth	70	400	249	26	65	1	98.46	3	Cloud-sun
Constantine	25	550	338	19	63	4	93.65	3	Rain-cloud-sun
Croyde	800	3000	1820	2	36	3	91.66	3	Sun-heavy rain
Perranporth	200	4500	2783	2	64	2	96.87	3-2	Cloud-sun
Chapel Porth	0	40	19	42	8	1	87.50	1	Rain-drizzle
Constantine	300	900	658	6	38	1	97.36	2	Cloud-sun
Chapel Porth	180	800	588	10	61	1	98.36	3	Sun
	<b>1725</b>	<b>15690</b>	<b>10,455</b>	<b>4</b>	<b>407</b>	<b>16</b>	<b>96.06</b>		

Table 3

ID	Description example	Scale words	Scale	Numerical scale
375	“Undercurrent which you can’t see”	Undercurrent, invisible—both incorrect	Incorrect	1
355	“Currents under the water that pull you out or under and down”	Undercurrent is incorrect, but stated direction	Poor	2
006	“When the current goes back out to sea, can drag you out”	Stated force and direction	Satisfactory	3
173	“Water pushes you out, too strong and can’t get back in, swim around the current”	Stated force, direction and hazard	Good	4
125	“An offshore directed flow, driven by waves and controlled by beach morphology, can be dangerous”	Stated direction and flow, mechanism of rip fed by waves, morphologically controlled, and hazard	Excellent	5

Table 4

ID	Description example	Scale words	Scale	Numerical scale
346	"Can't remember"	Incorrect statement, don't know, unsure, or no.	Incorrect	1
096	"Don't know"			
257	"Safe surfing area"	Incorrect activity, but with one of correct action or indicated safety	Poor	2
003	"Surfers to stay inside"			
122	"You can swim"	Stated 1 of correct activity <u>or</u> location between the flags	Satisfactory	3
319	"Stay between"	<u>or</u> indicated safety		
320	"Swim between them"	Stated <u>combination</u> of correct activity, that it should be carried out between the flags, indication of safety	Good	4
229	"Safe to swim"			
018	"Swim in between the red and yellow flags, it's the safest place"	Stated <u>all</u> of correct activity, that it should be carried out between the flags, and indication of safety	Excellent	5
391	"Safe to bathe between, and the lifeguards are watching you there"			

**Table 5**

		Face-to-face from lifeguards	Information booklets/ leaflets	Internet	Radio	Beach-based demonstrations	Signage	Smartphone app	TV	Other	Total
<b>All respondents</b>	Count	173	98	88	38	114	162	45	165	90	973
	% of responses	17.78	10.07	9.04	3.91	11.72	16.65	4.62	16.96	9.25	100
	% of people	42.51	10.07	9.04	3.91	11.72	16.65	4.62	16.96	22.11	239.06
<b>Respondents not caught in a rip current</b>	Count	110	67	65	29	72	120	31	134	62	690
	% of responses	15.94	9.71	9.42	4.20	10.43	17.39	4.49	19.42	8.99	100
	% of people	36.91	22.48	21.81	9.73	24.16	40.27	10.40	44.97	20.81	231.54
<b>Respondents caught in a rip current</b>	Count	55	28	22	6	39	39	13	28	29	259
	% of responses	21.24	10.81	8.49	2.32	15.06	15.06	5.02	10.81	11.20	100
	% of people	56.12	28.57	22.45	6.12	39.80	39.80	13.27	28.57	29.59	264.28











